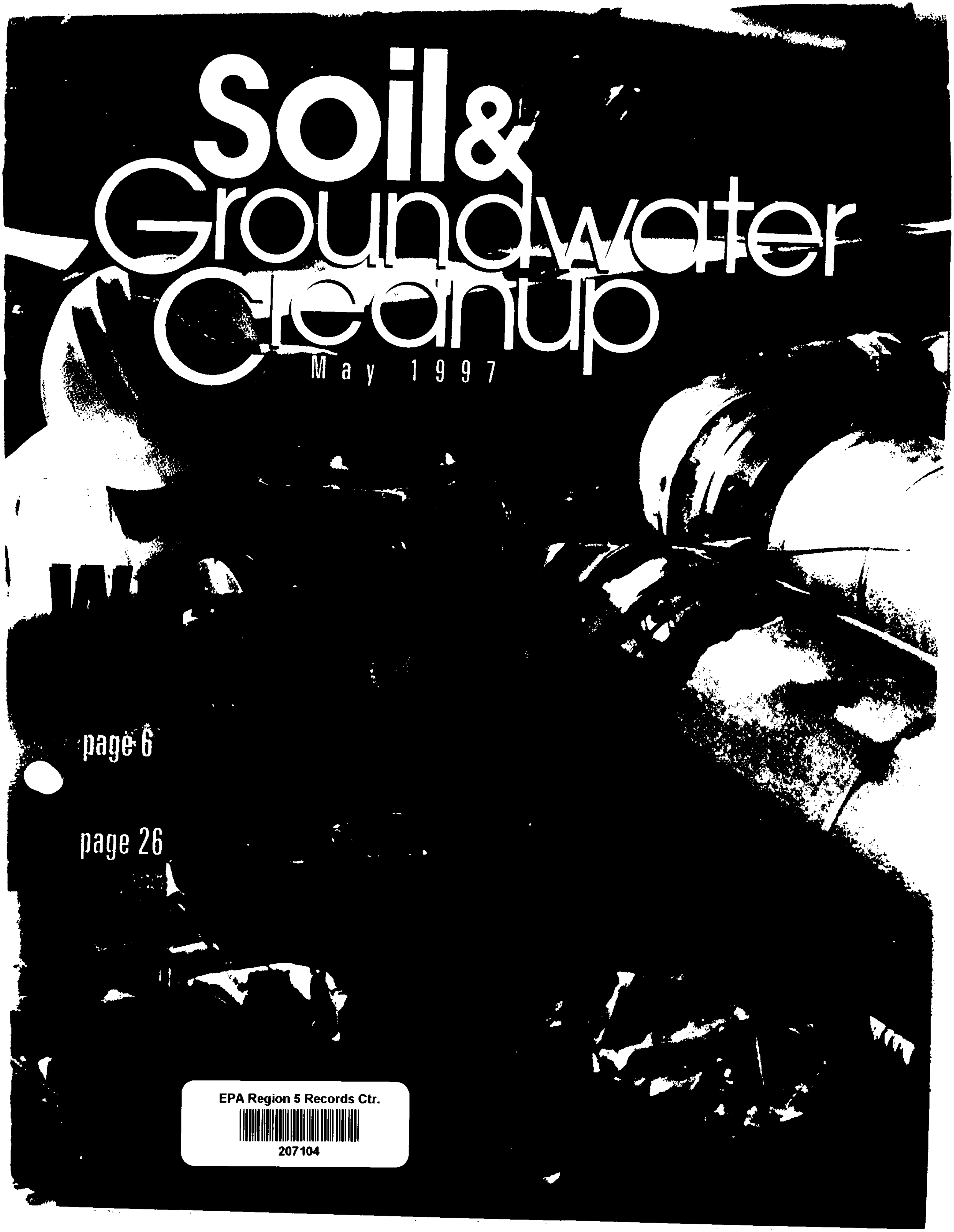
Soil & Groundwater Cleanup

May 1997



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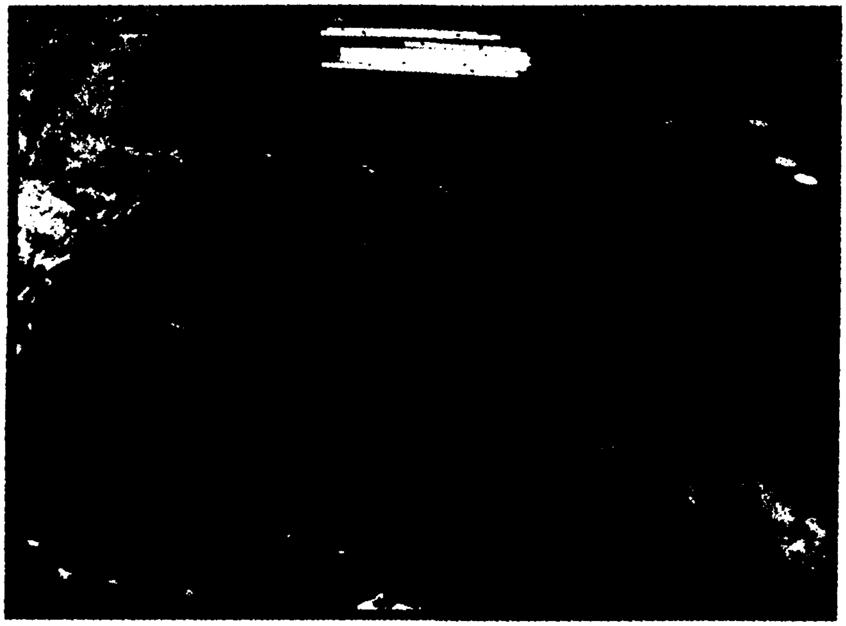
At right, thermal blankets are used to remediate PCB contaminated soil at the site in upstate New York. Once each blanket is connected to the trailer mounted vapor treatment system, the system is activated, drawing a vacuum and beginning the heating and treatment period. Below, clean soil is reddish brown and in contrast to the oil-blackened soil still to be remediated.

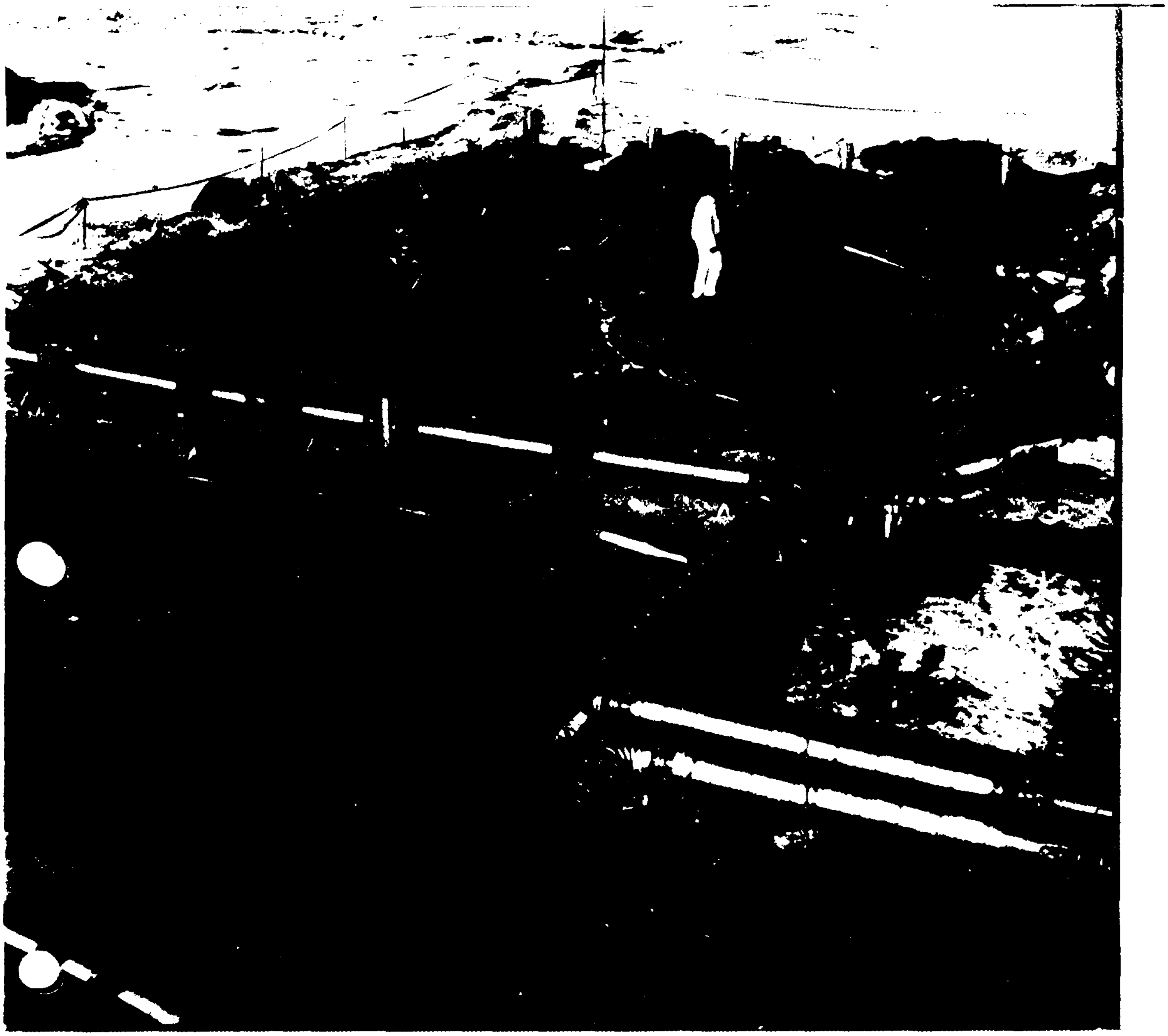


Throwing a blanket on the problem

New in situ thermal desorption technology remediates Superfund site

A new in situ thermal desorption technology, created by Shell Technology Ventures Inc. (STV) and marketed by a new Shell subsidiary, TerraTherm Environmental Services Inc., Houston, Texas, works in place to treat difficult remediation problems. This technology was used successfully in its first field application on a Superfund site in upstate New York that had near surface PCB contaminated soil as high as 5,000 ppm. Contaminants were reduced to below 2 ppm.

The application suggests that the thermal blanket is effective on contaminants to a depth of about a meter. The in situ thermal desorption process in an integrated system with two key components: the thermal blanket and a vapor treatment system. Monitoring of the system takes place in a trailer located on site. A backup power generator is used to ensure no interruption in service.



How it works

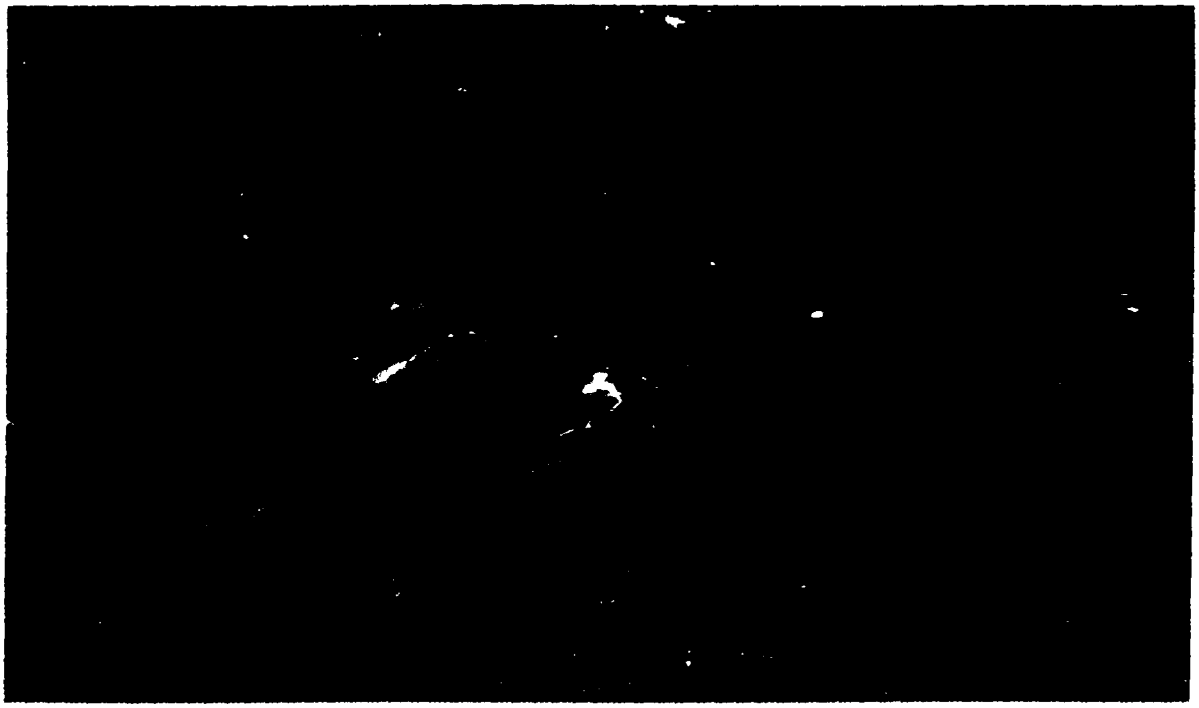
Thermal blankets are placed over the contaminated soil. Contaminants are vaporized by heating the soil with the blankets. Heating elements in each blanket reach up to 800° to 1,000° C at the surface. As the heat front moves through the soil, contaminants are vaporized and a vacuum system draws the vapors toward and through the blankets. Most contaminants are destroyed in the soil near the heat source.

Remaining vapors are cleaned in a trailer-mounted vapor treatment system, which emits only carbon dioxide and water vapor. The remediated site is then ready for revegetation.

Thermal blanket treatments are designed with the aid of computer simulations which predict remediation levels and cleanup times. Monitoring is done throughout the remediation process, and soil samples are taken before and after remediation. These soil samples show uniformity between the simulations and actual results.

Successful remediation of a Superfund site

The field demonstration of the desorption process began in early 1996 in South Glens Falls, N.Y. during one of the harshest winters experienced in that area in years. The demonstration was performed as part of the regulatory process to obtain a nationwide Toxic Substances Control Act (TSCA) permit for remediation of surficial soils containing PCBs in soil concentrations up to 5,000 ppm. RT Environmental Services Inc. King



Thermal wells have been developed to deal with deeper contamination. These thermal wells, remediating a site in Indiana contaminated with chlorinated solvents, have been drilled vertically to a depth of 6 meters. The technology uses heating elements placed in wellbores drilled on a regular pattern, typically 2 to 3 meters apart. Wells can be drilled horizontally and under structures.

of Prussia, Pa., was the general contractor selected by Shell to remediate the site.

The site was part of the former South Glens Falls Dragstrip with an average PCB concentration of more than 500 ppm. The PCB concentration in the treatment zone ranged from 75 to 1,264 ppm, with a maximum concentration of 5,212 ppm within the test locations.

Treatment times ranged from slightly more than 24 hours to treat the upper 152 mm to about four days to treat contaminants 305 mm to 457 mm deep. The temperature profiles and remedial efficiency have been history matched using a thermal simulator which showed that process timing, energy utilization and cleanup levels are all predictable. Post-treatment samples demonstrated the capability to achieve stringent soil cleanup levels of less than 2 ppm from PCBs while meeting ambient air quality standards with respect to air emissions and worker exposure limits.

The thermal blanket system, consisting of an electrically-heated, impermeable blanket assembly with vapor collection, was placed directly on the surface of the area to be treated. PCBs, other organics and water in the soil vaporized as the soil beneath the blanket was heated. Oxidation occurred in the surface soils. An in-line vacuum, created by a blower, swept clean air into the thermal blanket system and collected vapors from the soil.

Overview of the site operation

The demonstration was conducted on a total area of about 446 square meters. Six applications, using five thermal blankets for each applications, were conducted with each application covering a 74 square meter area on soil with PCB concentrations averaging above 500 ppm.

The vacuum carried the generated vapors from under the blanket into the vapor treatment system, first through the cyclone separator to capture particulates and then through the flameless oxidizer where the PCBs and other hydrocarbons were converted predominately into CO_2 and water.

The vapors were then cooled to between 80° and 180 C before passing through the granular carbon adsorption unit. The temperature in the carbon unit was maintained at 80° to 180° C to prevent condensation of water vapor in the off-gas. Treated air was vented into the atmosphere.

The system in detail

Each thermal blanket is a 2.5 meter by 6 meter stainless steel frame with three temperature measuring and control elements called thermocouples. Suspended from the bottom of the frame is a layer of steel webbing, which looks like a chain link fence.

Heating elements, threaded through the webbing, are used to transfer heat into the soil below the blankets. The bottom of the blanket is flexible and conforms to surface contours. The blankets are transportable and corrosion resistant at temperatures up to 1,110 C. A light gauge stainless steel sheet vapor barrier encloses the blanket on top. It caps about 152 mm to 305 mm of insulation.

After placement in the treatment area, the blankets are covered with a fiberglass reinforced, impermeable rubber sheet and sealed to the soil along the edges by ballast of hoses filled with sand. Each blanket connects to the vapor treatment system, which includes the vacuum unit, cyclone separator, flameless oxidizer and activated carbon adsorber/filter.

The system was powered by a 13 kV electrical feed to a 15 kV disconnect switch on a utility pole. The utility feed was connected to a mobile substation located nearby. Power to the blankets and vapor treatment system was provided through distribution panels in the substation.

Each blanket assembly can be individually regulated through separate power regulators to maintain the desired temperature. The installation of noise reduction measures allowed the system to run continuously without affecting the community or the system's performance.

Operation parameters

Four parameters monitored and assured performance efficiency: oxidizer temperature, carbon monoxide concentration in effluent, flow rate through the system, and vapor temperature at the carbon bed inlet. Post-treatment sampling results indicated the field demonstration objects were achieved. The measured PCB concentration in the remediated soil and stack emissions confirmed effectiveness of the system. No emergency conditions occurred during the demonstration that required EPA notification.

Sampling objectives and achievements

Soil samples collected before and after remediation were designed to meet the following objectives:

- Demonstrate the technology is capable of removing PCBs from soil to a concentration less than 2 ppm at the treatment depth.
- Determine the quantity of PCBs removed from the soil.
- Demonstrate PCBs removed from the test area were captured and did not migrate to surrounding clean soil.
- Demonstrate the technology can remove residual concentrations of PCBs from soil to a depth up to 457 mm below original surface grade.

For pre-treatment soil sampling, the site was divided into 30.5 meter by 30.5 meter grids to delineate the concentrations of PCBs in the soil. The PCBs were found primarily in the top 150 mm of soil across the site. Pre-treatment samples were collected to verify the average concentration in the test area and determine the concentration variance within the test area.

At four locations, two soil sample plans were prepared for the demonstration test. The first plan covered where soil samples were to be collected and how they were to be analyzed before and after the three stack test demonstration runs. The second plan was related solely to the final demonstration test run that was used to remove residual PCB concentration down to 457 mm below the surface in a single area.

At each of the six demonstration test runs, post-treatment samples were collected at 10 discrete position in each of the six test areas. A surface composite — 0 to 150 mm — was prepared in all six test areas. Surface discrete samples and a shallow composite — 0 to 75 mm — were analyzed in two test areas. Deep soil samples — 150 mm to 305 mm — were collected in three test areas.

At the EPA's request, discrete samples were analyzed to verify that lateral and vertical migration did not occur as a result of treatment. Samples were collected to evaluate the potential for lateral migration of PCBs from the heated area, and transport and condensation of vapors into the surrounding unheated soil.

Other monitoring efforts

Ten Type K inconel-sheathed thermocouples were inserted into the soil beneath the five thermal blankets at a depth of 150 mm to measure soil temperatures. Each heating module had three thermocouples placed on electric heaters to monitor heater temperature.

Temperatures were monitored continuously during the tests. Soil temperatures during the demonstration test were automatically recorded. Temperatures continue to rise at depth as the thermal front moves downward in the soil, depending upon how long heating has taken place. For targets at 200 mm, the typical temperature rise will be less than 50° C and lasts about six hours. Vacuum and processing must continue throughout this period.

Three continuous stack tests were performed. These stack tests were consistent with EPA Method 23 procedures to determine the quantities of PCBs, polychlorinated dibenzo-p-dioxin, polychlorinated dibenzofuran (PCDD/PCDF) and semi-volatile products of incomplete combustion released to the environment from the thermal blanket system. Better than 99.99999 percent of the PCBs entering the treatment system were successfully collected or destroyed.

Superfund success story

Remediation of the Glens Falls site exceeded expectations. Use of the thermal blanket system was successful in consistently treating the soils containing PCBs up to 5,212 ppm in depths up to 457 mm without detrimental effects to public health or the environment. The PCBs did not migrate away from the thermal blankets during treatment. Stack emissions tests were far below existing or recommended standards. Existing or recommended worker exposure levels were not exceeded. The approach was cost-effective and less intrusive.■